Botany

Preparatory to Veterinary Medical Studies

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Outlines

OF

Lectures

ON

Botany Preparatory to Veterinary Medical Studies:

Especially as an Introduction to Veterinary Materia Medica, Pathology, Toxicology and the Feeds and Feeding of Animals,

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DEDICATION

THIS BOOK IS DEDICATED TO BEGINNERS IN VETERINARY MEDICAL STUDIES IN THE HOPE THAT ITS PAGES MAY HELP TO SECURE INFORMATION ON THE RELATION OF THE COMPOSITION OF PLANTS AND THE PRODUCTS OF PLANTS TO ANIMAL GROWTH, THE DISEASES OF ANIMALS AND THEIR MEDICAL TREATMENT.

D. Arthur Hughes

A Brief Preliminary Address of Explanation

The beginner in Veterinary Medical Studies is apt to experience much difficulty in note-taking when he listens to lectures on technical subjects. It is the duty of the instructor to minimize this in any way which, while it does not weaken the course of instruction, enables the student to follow more easily the line of thought of the teacher and at the same time helps him to grasp what is being taught. These outlines of lectures on botanical topics, containing the gist of a portion of information which the beginner in Veterinary Medical Studies should have before he passes on to the more strictly professional subjects in the veterinary curriculum which are to follow, will, we may be sure, help first-year students to learn the facts presented without the strain of feeling that any lecture, or part of one, has been useless, owing either to the forgetfulness of the teacher in covering the

matter too rapidly, in which he has not shown enough appreciation every moment of the beginner's difficulties, or else it may be due to the confusion of the listener, who fails to continue the thread of thought. To aid both lecturer and listener to avoid this condition of affairs, was the motive in publishing these lecture outlines.

In the crowded veterinary curricula, as they are mapped out today under requirements of official authorities—national or state—not much time is alloted to the science of botany, which is a branch, like chemistry, physics, vertebrate and invertebrate zoology and entomology, underlying the more important veterinary branches to which much time must necessarily be given in clinic, laboratory and lecture room during the later years of the veterinary curriculum. Accordingly we have thought that the time set apart for botany may best be utilized in imparting in the course of lectures, of which this book contains the outlines, some knowledge of botany fundamentals which veterinary students of the first year should know, leaving to the senior year instruction on poisonous plants, cryptogamous and

phænogamous, which are so widely destructive to live stock in the United States.

Hence in the lectures, outlined in this work, it is assumed that beginners have enough knowledge beforehand of the rudiments of descriptive botany to enable them to understand the purposes of the organic elements of plants. Much time is given to plant physiology—protoplasmic phenomena, development, the circulation, respiration, absorption by plants, and then transmutation whereby organic and inorganic materials are formed and made available for the manufacturing chemist and finally for veterinary medical use, the object being to give the beginner an understanding of the bearing of Medical Botany on Materia Medica. The inorganic and organic materials of medicine are treated of in enough detail to indicate to the student the dependence of the veterinary pharmacist for his preparations upon the nature of plant life. Attention is also called to the relation of the composition of plants to animal growth and the diseases of animals. In this way the veterinary student is led to see that the knowledge of Medical Botany he has obtained helps him to under-

stand the origin of materials of medicine so that drugs and pharmaceutical recipes are something more than shadows and names. It shows him why certain feeds are nutritious for animals and the underlying reasons for feeding plant nutrients. It better prepares him, at least in some degree, for the biological information he is to receive in his studies of veterinary pathology and toxicology. For what does it profit the veterinary student to be told that a pathologic or toxic condition has been induced in an animal, through the presence of plants, their parts or their products, unless he understands beforehand fundamental facts about plant life?

Contents

Lecture I

THE PLANT CELL IN GENERAL—ITS STRUCTURE, COMPOSITION AND PRINCIPAL CONTENTS

The Cell

Fundamental component of which fabric of plants is formed and from which histological elements are derived.

Even fibres, ducts, are cells transformed, or simple combinations of them.

They are organs and even organisms.

Of What Cells Consist

Of a cell wall with essential contents—*i. e.*, living matter of cell enclosed in envelope—cell wall.

Essential Element of a Cell

That essential to vital activity—half solid substance,—protoplasm.

Protoplasm

Exists in all living cells (*e. g.*, soft core of

tissue in buds, in root tips), is a nearly transparent or granular substance. In young cells fills wall.

Is essentially transparent, but usually mixed with other matter, so looks granular.

Solidity—depends on water it contains. In dry seeds tough like horn. In germination like gelatin. Absorbs water readily.

Chemically, it belongs to albuminoids, of which white of an egg is an example.

Nucleus—Spherical or elliptical mass found in protoplasmic mass; more dense.

Nucleolus—Sharply defined point in the center.

Cell Wall

Is produced from materials in protoplasm closely connected with protoplasm. Its hardness or softness depends upon conditions of growth. May become like gelatin, or densest wood. Is colorless, but may become colored.

Chemical Character of Cell Wall

Consists of cellulose which is not the same as, but closely related in composition to starch. Has mineral matter in it. Is permeated by water.

Cellulose not Dissolved

By water, glycerin, dilute alkalies or dilute acids.

Cellulose is dissolved—in hot strong alkalies or acids.

Modification of Cell Wall

May be converted:

1. (Partial or complete) into mucilage (gelatinization.)
2. Lignification.
3. Cutinization.
4. Mineralization.

Its chemical character changed in gelatinization, but not in others.

I. Gelatinization

Cell wall not usually affected by water. Sometimes may absorb large amounts; increases in size and is translucent. Such cell walls placed in water become a soft gelatin, which then dissolves, forming mucilage.

Example, flax seed.

II. Lignification

Cell wall becomes encrusted (covered) with a substance known as lignin. It is much the same as cellulose. Found in different parts of plants and of the same plant.

III. Cutinization

Ordinary and lignified cells and those of mucilaginous degeneration absorb water freely. Many cells contain substance which keeps off water:

1. Cutin, waxy matters, found in many cell walls.
2. Suberin, which is found in cork. This affects whole structure of cell wall.

IV. Mineralization—of Cell Walls.

All cell walls show traces of inorganic matter. Cell walls may be mineralized wholly or partly.

What the minerals are:

a) Silicic acid.

b) Calcium salts.

What Protoplasm Produces

1. Exteriorally, forms the cell wall.
2. Inside the cell produces various substances.

Plastids

Certain granules are found imbedded in the protoplasm and which cannot be separated from it, called plastids.

Types of Plastids:

Three:

1. Those which are green, Chlorophyll granules or chloroplastids.
2. Those with other colors, chromoplastids.
3. Colorless, leucoplastids.

Chlorophyll Granules

Where chlorophyll granules are—green parts of the plant.

Shape, spherical.

Increase in size—frequently great size because of starch content.

Color—due to green pigment.

Place where starch is found—

1. Sometimes wholly within the granules.
2. Sometimes in the exterior of the granule.

Changes Which Take Place in the Chlorophyll Granules

If plant with granules is placed in the dark, are changed from green to yellow. If continued in dark entirely loses color.

Leucoplastids

Found in parts normally devoid of color—tubers, rhizomes, etc.

Are colorless.

Office—are points around which starch accumulates.

Chromoplastids

Are the color granules which occur abundantly in flowers and fruits.

Protein Granules

Two classes:

1. Active—the nucleus, etc.
2. Reserve—which may become active when occasion demands.

The protein matter in protein granules may be:

1. Wholly without shape.
2. May be of crystal formation.

Character of the Granules

a) Stroma—basis in which the protein matter is held.

b) The protein crystal-like bodies held by the stroma.

c) Certain inorganic contents—Ca. and Mg. salts.

Starch

Elaborated by the plants and held in reserve for food and growth.

Form—takes the form of minute spherical or many-sided granules.

Found in layers.

Occurrence in plants—in all stages of development.

Size—very variable.

Effect of saliva and pepsin on starch—

1. The granulose or starch content passes into solution.
2. The starch cellulose, or framework which holds the starch, remains.

Inulin

Greatly resembles starch.

Occurs in solution in cells.

Substances Dissolved in the Cell Sap

1. Substances which are essentially like cellulose.

   Mucilage.
   Gums
   Dextrin } All derivatives from starch.

a) Mucilage—

   Results from breaking up of cellulose.

b) Gums—

   (Example cherry gum). Derived from cellulose.

c) Dextrin—

A substance much resembling grape sugar.

2. The sugars.

a) Grape sugar.

b) Cane sugar.

Both found in solution in cell sap.

Crystals:

Are of wide occurrence in all higher plants.

Found in nearly all parts of these plants:

1. Sometimes in the cell wall.
2. Often within the cell.

Form—Very diverse shapes, needle shaped, sphere, cube, three sided, four, five, six or more.

Chemical character—unknown.

Lecture II

PROTOPLASM AND ITS RELATION TO ITS SURROUNDINGS.

Cells and Framework of Plants

Framework imparts strength to the plant; living cells are distributed through it.

What are Living Cells?

Those that contain protoplasm.

The relation of the cells:

Each related to its neighbor and the external world.

The Character of Protoplasm

1. Exists in cells as a nearly colorless mass lining walls and extending irregularly from side to side as slender threads.
2. Nucleus.

   At a point the protoplasm appears a little denser. Its outline more or less clear—the nucleus.

3. Circulation of protoplasm in the cells.
   The threads of protoplasm have embedded in them granules which are in motion.

Features of the motion:

a) The granules do not pass from one cell to another, but remain confined to one.

b) The threads alternately increase and decrease in size.

The movement of the granules from one place to another is called the circulation of protoplasm.

4. There is an accumulation of the protoplasmic mass in the vicinity of the nucleus.

Rotation of Protoplasm in the Cells

Film of protoplasm in contact with the cell wall remains stationary.

The mass of protoplasm revolves on its axis, carrying with it the embedded granules.

Rate of Protoplasmic Motion

Exceedingly slow. Differs much in different plants.

Temperature has much to do with it.

Rate same for same part of a given plant.

Relation of Protoplasm to Heat

The rate of protoplasmic motion is accelerated by heat up to a given point (optimum).

With increase of temperature beyond this point movement continues, but is less rapid.

At upper limit of temperature movement ceases and death of protoplasm ensues.

Maximum temperature for many plants—80 deg. F. Sudden changes of temperature cause temporary arrest of movement.

Minimum Temperature—When subjected to temperature lower than minimum protoplasm becomes disintegrated. Solid part separates from watery part.

Watery part freezes. By gradual return of heat the disorganized parts become reunited. No such recovery after passing maximum of temperature.

Protoplasm of seeds and spores—Retains vitality during exposure to dry air.

Relation of Protoplasm to Light

The circulation of protoplasm goes on in darkness as well as light, even though plant hairs are blanched by absence of light.

Light has little to do with circulation except as heat accompanies it.

Relation of Protoplasm to Electricity

Chemical changes in plant make electrical currents.

These tend to protoplasmic inactivity—*i. e.*, to check protoplasmic activity.

Effect of Mechanical Irritation Upon Protoplasm

Only temporarily arrests protoplasmic activity—continues after removal of mechanical irritant.

Effects of Gravitation Upon Protoplasm

In dense plant body gravitation has little effect upon protoplasm. In less dense plant body plant yields to gravity.

Relation of Protoplasm to Moisture

Large amounts of water are favorable to protoplasmic activity.

Relation of Protoplasm to Various Gases

O. is essential to protoplasmic movement.

Chloroform and ether arrest the movement of protoplasm.

The Structure of Protoplasm

Under the highest power microscope it appears as a homogeneous hyaline mass holding in its sub-

stance minute granules. It has a reticulated framework of extremely delicate fibrils.

These are the only facts known about the structure of protoplasm at present.

Relation of Protoplasm in one Cell to that in Another

The protoplasm in one cell is not shut off by imperforate cell wall from that of another.

The protoplasm in one cell is practically continuous with that in another by delicate fibrils passing from one cell wall to that of another.

Protoplasm can pass through cell wall without breaking cell wall.

Relation of Cell Wall to Protoplasm

Formed by the conversion of outer film of protoplasm to cellulose intermingled with other matters. The cell wall is practically a homogeneous film of cellulose which undergoes chemical and physical change.

Mode of Growth of the Cell Wall

The wall is formed either by deposition of cellulose from the protoplasmic content or by the deposition of layers of cellulose from without.

Lecture III

GROWTH OF PLANTS.

In What Does the Growth of Plants Consist

1. Formation of new cells.
2. Increase in size of previously existing cells.
3. In both of these processes taking place simultaneously.

Chemical and Physical Phenomena Accompanying the Production of New Cells or Their Increase in Size

I. Chemical.

Available matters:

1. In air.
2. In soil.

Are changed in character in order to bring about formation of new cells and their increase in size.

Called:

Respiration—breathing things in from the air.

Transmutation—change within the plant of the material taken in from the air and soil.

2. Physical—

a) Elimination of heat.

b) Production of electrical phenomena.

These accompany oxidation.

How Materials are used by Plants for the Formation of New Structures

By assimilation:

This material consumed in growth by annuals.

This material stored by perennials.

How Growth has been Studied

The structure of lower plants is so simple that living cells have been studied in all various stages. It is assumed that the law of growth is same in all cells and development of parts of all plants.

Meaning of Neucleus and Neucleolus

Nucleus:

Spherical or lenticular body.

a) Seen in the cell and apparently denser than the protoplasm.

b) Is firmer, more resistant than the rest of the cell.

Nucleolus:

Large firm granule or granules within the nucleus.

Substance of the Nucleus

a) Basic substance or network of rods, threads or fibres. These less highly colored than the rest—achromatin.

b) Part which takes the color readily—chromatin.

What Occurs in Cell Division

a) These parts of the nucleus undergo remarkable changes in shape and position.

b) Change takes place in the nucleus as a whole.

Illustration—

Development of stomata:

1. Nucleus grows in size and becomes granular, but does not lose its place in the protoplasmic mass.
2. Faint stripes appear which converge towords the poles of the spheroidal nucleus. Midway a row of granules appear at the equator.
3. The granules pass along meridian line towards poles and accumulate to form new nuclei.

4. From this point the development is rapid until the completion of the cell division.
5. While the splitting is taking place cellulose is being formed—at first in spots and then uniformly to form the cell wall.

Growth of the Cell Wall

When new cell is formed it undergoes changes of shape and thickness:

a) If shape is even, the original shape remains.

b) If uneven, many modifications take place.

Conditions of Growth

Growth of plants does not occur unless—

1. There is an available supply of assimilated matter.
2. Access of free O.
3. Sufficiently high temperature.

How Assimilated Matter may be Supplied

a) Directly from the green tissues.

b) From reservoirs where it is stored.

Must be in solution to be availed of.

Relations of Growth to Temperature

1. If O and assimilated matter is supplied to

plant, but temperature low or too high, growth does not occur.

2. The temperature at which plants grow varies according to region where plants grow.

Common optimum is 20-36 deg. centegrade.

Relations of Growth to Light

1. Only under influences of light can plant prepare from inorganic matter materials for growth.
2. Growth can go on in the dark if an adequate amount of assimilated matter has been stored up. It is in dark that nearly all growth takes place. Growing tissue is usually concealed beneath external structures.

Relation of Growth to O

All growth accompanied by oxidation of assimilated matter in food.

Supplying excess of O does not stimulate growth apparently.

The resting stage of plants cannot be shortened by supplying excess of O.

Periodical Changes in the Rate of Growth

Growth not constant even when external conditions are constant.

There is gradual rise in the rate of growth, followed by decline.

Properties of new Cells and Tissues

1. Young cell wall offers resistance to expansion of contents within.
2. Contents compressed by wall.

These vary with changes in surroundings.

Tension in Cell Wall

1. Young cell wall elastic.
2. If stretched, remains in stretched condition.

Tension of Tissues

In growth the young cell continues to be elastic and hence have variety of tensions.

Marked difference in tension between internal and external cells of an organ, the external giving way to the internal because of their elasticity.

Geotropism

This is a tendency of the nutritive fluids to collect, because of gravity, on the under side of an

organ. The lower cells of region have larger amount of nutrition material for growth.

The result is root formation and assumption of upright position by plant.

Heliotropism

The curvature of plants towards side of greatest illumination. Yet little is known of the influence that light exerts on plants.

Hydrotropism

The deviation of roots or other parts of plants towards moist surface or region.

Thermotropism

The curvature of plants toward warm places.

Assumption of Definite form During Growth

This depends upon inherited tendencies.

The Amount of Force Exerted by Organs of Plants During Growth

This has in many cases been accurately measured:

Example—

Bean—(Darwin) Growth of bean can displace weight 3-8 lbs. That beans by increase in

length and thickness pushe damp earth on all sides with a force of 2-8 lbs.

Squash—Form placed around growing squash and found that exerted a force in growth of 5000 lbs.

Lecture IV

THE ABSORPTION OF LIQUIDS BY PLANTS.

What is Meant by Diffusion of Liquids

1. The non-diffusible—when two liquids not capable of being mixed (example—oil and water) are shaken and left at rest they separate off.
2. Diffusion—
   a) Two liquids which can be mixed are shaken together, they remain evenly mixed.
   b) When two miscible liquids are left together (no agitation) they become commingled. Both are forms of diffusion.
3. Osmosis—
   Two miscible liquids placed together, separated by a membrane which they moisten. The two become evenly mixed.

Does Diffusion of Liquids Occur in Plants?

Yes, all kinds occur in plants and their surroundings.

The Rate at which Diffusion Takes Place

Varies—

1. With the nature of the liquids.
2. With the temperature.

Solutions of Salts

Those of different strengths diffuse at different rates.

Example—

a) Crystalloids—sugar and the like are rapidly diffusible. Burnt sugar (caramel) is slowly diffusible.

b) Colloids—(glue-like bodies) gelatin, are slowly diffusible. They are held in solution feebly.

The Rate of Temperature to Salts

The rate of diffusion is somewhat higher than the temperature of the liquid.

Two Solutions of Different Kinds of Salts

Diffuse into each other same rates as into pure water.

Two Solutions of Salts, one Stronger, Other Weaker.

Rate is proportional to the degree of concentration.

Osmosis

Meaning—Placing a porous membrane between liquids, diffusion takes place as if no membrane were present,—*e. g.*, bladder, or vegetable parchment.

Colloids and Osmosis

Colloids in solution. For example—gum tragacanth, or gum arabic (acacia) as bulky gelatinous hydrate, has no power of osmosis.

The Active Vegetable Cell as an Osmotic Apparatus

All such cells are osmotic apparatuses.

Protoplasmic mass in the cell is surrounded by a film of cellulose, the cell wall, which is osmotic.

In case of plants, osmosis occurs, but no liquid passes out to replace the liquid absorbed.

Lecture V

ABSORPTION OF LIQUID THROUGH ROOTS.

Office of Roots

Absorption of liquids.

Office of Stems

Support of assimilative tissue.

Begin the study of roots with remarks on their structure and function.

Root Cap

Does not share in absorption, only protection.

Root Hairs

Have everything to do with absorption.

Shape

They are cyclindrical protuberances from epidermal wall.

Size

Size exceedingly small, delicate, fine. They are to hold the plant to the ground.

Vastly increased absorbing surface.

Extent of Root System

1. The root, by growth at protected extremity, insinuates itself between particles of soil which it cannot thrust.
2. Branches of main roots extend by continual additions behind tip.

Area Occupied by Root

Very large.

Sunflower—total length of roots 1500 feet.

Difficulty of ascertaining root system—they break off.

Run water over roots—thus peas, beans and common cereals richly branched, 1½ feet.

What Influences Development of Roots

1. Nature of the soil.
2. Amount of moisture and nutritive matter. Fertility of soil favors copious branching.

Extent of Roots

May be very great—elms known to fill drains 50 yards away.

Forest and Shade Trees

Roots extend to eaves of shade formed by branches above ground.

Root System

Continually spreads by subdivision into new soil.

Clothed near extremities of the roots with delicate epidermal cells, is under most favorable condition for absorption.

Lecture VI

TRANSFER OF WATER THROUGH THE PLANT.

Water is a constituent of all active cells—protoplasmic body of the cell has a marked affinity for it.

Plants Which Grow in Air

1. Have a surface which protects them from great loss of water.
2. Provided with a system by which the needed supply of water can be replenished.

Loss of Water by Plants

1. By evaporation.
2. Water is consumed in the work of the plant.

How Transfer of Water Takes Place in Woody Plants.

In woody plants transfer takes place through the woody tissues—from roots through the stem—

that is through the lignified cells,—cell walls of the framework of the plant.

Method of Transfer

1. Roots furnish the needed amount of water to ligneous tissues of the fibrils.
2. The fibrils convey it to the converging bundles which constitute the framework of the plant.
3. The leaves' framework divides and subdivides to form the net work of the leaf blade—here ligneous cells and ducts are in intimate connection with parenchyma cells of the leaf ducts.

Summary—

Water transferred through the fibro-vascular bundles by preference.

Effect when Stability of Equilibrium of Water within Plant is Broken

Water in relatively small amounts is held in stable equilibrium in unicellular pores of woody cell wall.

This equilibrium by evaporation at any one point may be distributed, disturbed and water immediately transferred to that point.

Loss by transfer must be made good by taking in more water.

This may take place through any length of woody tissue.

Slow—

1. In opening of buds.
2. Chemical changes in plant.

Presence of Sap

a) External influence.

Rise and fall with temperature. Greatest pressure in ligneous plants when cold night is followed by warm morning.

b) Internal influences.

Periodical transfer of water as sap takes place from internal causes also. These not understood.

Winter Conditions of Internal Portions of Woody Plants

To a large extent they are stored with starch manufactured in previous season.

With warm weather season and ascent of water from ground, the starches become liquefied and chemically changed.

Example—

Saccharine sugar or syrup of the sugar maple is starch changed in this way.

Lecture VII

TRANSPIRATION.

Meaning—

Evaporation from a plant.

Occurs—On surface of a plant exposed to air.

Stomata—where Evaporation Takes Place

Evaporation of water from plants (transpiration) takes place at myriads of points on the epidermis of leaves, and young stems, of plants.

By these, stomata, air within plant comes in contact with air without.

Water absorbed by roots is finally brought into contact with parenchyma of leaves and makes its escape.

Mechanism of Stomata

Consists of three parts—

1. Outer groove.
2. Cleft.
3. Inner groove connected with air chamber.

Relations of Stomata to External Influences

1. Widens cleft when water is applied to leaf.
2. Open more widely in light than darkness. In darkness they close.
3. Heat has no marked effect on them.
4. Close on sudden shock.

Amount of Water given off in Transpiration

Example—

Sunflower 3½ feet high, during twelve hours of a warm day, 1 lb. 4 oz.

Quantity of water exhaled from upper surface of leaf to that of lower—1.1, 1.3, 1.5.

There are marked relations between the amount exhaled and amount of stomata.

Effect of Moisture in Air on Transpiration

With increase of moisture in air the amount of water transpired is diminished.

Effect of Soil on Transpiration

More uniform from foliage of plants grown in clay than those grown in sand.

Reason—clay soil holds water and gives it off gradually.

Chemical properties of soils affect transpiration.

a) Little free acid increases.

b) Alkali retards.

Temperature and Transpiration

Rise of temperature increases transpiration.

How?

a) By aiding absorption of water.

b) By affecting evaporation in general.

Effect of Light on Transpiration

Goes on more rapidly in light than in darkness.

Effect of Shock on Transpiration

Shaking increases it apparently.

Continued shock diminishes it.

Effect of Age of Leaves on Transpiration

Young leaves moist.

Diminution up to old age.

Relation of Transpiration to Absorption

Transpiration by the leaves is the chief cause of absorption by the roots.

Checks upon Transpiration

When plants become adapted to dry climates

a) By reduction of leaves.

b) By denser texture of leaves.

c) Provision of water store.

Effects of Transpiration on the Plant

1. Transfer of dilute solutions of mineral matters to cells where production of organic matter takes place.
2. The concentration of these dilute solutions by evaporation.

Lecture VIII

RELATIONS OF PLANTS TO SOILS.

Residue of Plants

When plant is dried, at a temperature just above boiling point, get a brittle combustible residue.

Amount of Water in Plants

Difference between original weight of plant and weight of residue after drying.

Amounts differ:

Example—

Dry grains, 14-15 per cent.

Red clover, 6-3 per cent.

Ash Constituents in Plants

When residue is burned in air we get a small amount of grey ash.

Varies in amount; *i. e.* Indian corn, 1.1 per cent. Red clover, 1.5 per cent.

Combustible Parts

Derived from the atmosphere.

Imcombustible Parts

Derived from soil.

What is in the Soil which the Roots Absorb

1. Water.
2. Saline matters.
3. Gases.

How Soils are Formed

They are formed by the breaking down (disintegration) of rocks.

Breaking down is:

a) Mechanical—Cracking, attrition, or action of frost.

b) Chemical.

Mixture of Soils with Organic Matter

Are constantly being mixed with decomposing animal matter.

Soils Exposed to Air Change Chemically and Physically

Because of action:

a) Moisture.

b) Carbonic acid.

c) O.

Effects of Water on Rocks

1. Breaks down by rubbing.
2. Breaks down by expansion in freezing.

Effect of Carbonic Acid and other Matters on Rocks

Water containing carbonic acid dissolves rocks and brings about new chemical combinations.

Rain water often has other chemical matter besides carbonic acid, which aids in decomposing rocks.

Effect of O on Rocks

Free O, in air, rapidly oxidizes many rocks, making them brittle, and they break down.

Example—

Rocks containing sulphides; rocks containing ferrous oxide.

Water as a Distributor

Water carries particles of soil and rock to great distances from their source, depending on weight.

Glaciers and Soil Forming and Soil Carrying

a) Glaciers of Alps.

b) The glacial age.

Kinds of Soil

1. Gravelly.
2. Sandy.
3. Clayey.
4. Calcareous (chalky.)
5. Loamy.
6. Peaty.

Gravelly Soil

Made up of pebbles, composed of quartz or limestone.

Sandy Soil

Composed of compounds of iron, feldspar, quartz and mica—broken down granite.

Clayey Soil

A heavy soil, adhesive, contains water and dries in a hard mass.

Calcareous Soil

Contains chalk, calcic carbonate predominating.

Peaty Soil

Contains much pulverized vegetable matter.

Growth and Nutrition of Plants Affected by

1. Liquids.

2. Gases.
3. Heat.

Absorption of Moisture by Soils

This is taken from the air in the form of vapor.

Temperature and Soils

Variety of temperature raises, or lowers, capacity of soil to gather moisture.

Degree of Fineness of Soils and Absorption

This increases power of absorption in some cases, decreases it in others.

a) Soil may be fine and compact so as to stop absorption.

b) Soil may be porous as not to retain moisture.

Constant Movement of Water in the Soil

a) Evaporation takes place from surface or water is precipitated upon it.

b) When surface is dry, water rises from below to moisten it by capillarity.

Power of Soils to Remove Saline and Organic Matter from Water

a) When saline matter passes through soil, loses saline character.

b) Organic matter in water, including sewage, freed from solution.

Power of Chemical Absorption by Soils

Different substances are absorbed by soils in different amounts.

Soils change the chemical character of liquids passing through them.

Absorption of Gases by Soil

Soil has the power of condensing gases and taking them into its pores.

In soil there is less O than in the air.
" " " " more N " " " "

Soils have more CO_2 than air, especially those rich in organic matter.

The Conditions under which Roots May Extract These Matters from the Soils

1. The presence of O.
2. A sufficiently high temperature.

3. Presence of the material in available form, in soil.

Free Oxygen

For activity of protoplasm, presence of O is necessary.

Different plants require different amounts.

Exclusion of O from the roots ruins plants in no time.

Temperature

The temperature needed varies with different plants.

Rule is, that absorptive power increases with the increase of temperature.

Heat is derived from the sun and amount absorbed varies with the soil—dark soil, lighter soil.

Saline Matters in Available Form in the Soil

Must be in such a form that plant can make use of them :

a) In solid form, of no use.

b) Too abundant of one kind; plant can only absorb definite amounts.

Lecture IX

ASH CONSTITUENTS OF PLANTS.

Where Found

These are in all parts of plants. Cell walls are encrusted and impregnated with mineral matters.

Total amount—varies in different plants and in different parts of the same plant. Amount varies from ½ of one to 3 per cent.

Composition of the Ash of Plants

Certain elements are always present in it: K. Ca. Mg. and P.

Others usually present in small amounts: Fe. Ch. S. and Na.

How Found

Potassa. Phosphoric Acid, Lime, Magnesia, Sulphuric Acid, Soda, Ferric Oxide.

In the act of combustion large amounts of carbon are combined with these.

Normal Constituents of the Ash of Plants may be Divided into Four Groups

Group 1.

Sulphur and Phosphorus—essential because enter into composition of living substance.

Sulphur—all analyses of protein show S. as an essential constituent of them.

Phosphorus—essential element of the nucleus, and of nucleins.

Group 2.

K. Mg. Ca. Fe.

Essential to development; but do not form part of the living substance.

Group 3.

Not absolutely essential, but useful in many ways. Na. Sil. Mangan. Ch. Br. Iod.

Group 4.

Occasionally present. Happen to be present in soil and absorbed. Not essential to plant. Al. Zn. Co. Cu. Ni. Fl. Lith.

Rules

1. Plants which resemble each other in structure have about the same amount of ash.

2. The proportions of ash in any part of a plant vary within certain limlts. The limits vary with the period of growth.

Note—

The ash constituents are always present in flowering plants. They are indispensable to their development.

Office or Purpose of Different Kinds of Ash Constituents

K. Potassium. Salts.

Plants need them for their growth.

Forms in which desired by plant—Chloride, Nitrate.

Reason—

1. The element must be present in order that any starch may be formed in leaves.
2. The transportation of starch from leaves to other parts of the plant depends on the form of K. and K Cl in the plant.

Ca. and Mg—Calcium and Magnesium.

Ca. is needed in the cell wall.

Mg. enters into the composition of cellulose supporting tissues of plants.

Ph—Phosphorus.

[Phosphoric acid, The Phosphates.]

Necessary for the transfer of albuminoids.

Iron.

Is necessary in the production of chlorophyll. The shape and green color of the granules is dependent on the presence of iron in the ash.

Chlorine.

Needed like K. to assist in the transfer of starch.

Sulphur.

Absorbed in soluble sulphates. Enters into the composition of albuminoids.

Sodium.

Small amounts of the element may take the place of K. in many plants.

Other Mineral Constituents Sometimes Found

Silicon—in grasses.

Zinc.

Found in abundance in many plants growing in soils impregnated with zinc compounds.

Aluminium.

Present in large amounts in many species of plants (lycopodium).

Iodine and Bromine.

Abundant in certain sea weeds. Fluorine, Barium, Strontium, Hg. Pb. Co. Cu., Tin and Arsenic are sometimes found in plants.

Lecture X

ASSIMILATION.

Meaning

The conversion by the plant, through the agency of chlorophyll, of certain inorganic matters into organic substances.

Appropriation of Carbon or Assimilation Proper

Appropriation of C. with its combination with the elements of water, H. and O., is the most striking of the kinds of assimilation.

Assimilation is Essentially a Process of Reduction

In this the organic matters are taken from the soil, and carbonic acid from the air and the organic substance produced is some carbohydrate.

Assimilation Takes Place only Under the Following Conditions

1. The assimilating organ must contain living chlorophyll or its equivalent.

2. Water and carbonic acid must be furnished in proper amount.
3. Rays of light of a definite character must beat upon the organ.
4. The temperature must be right.
5. Small amounts of inorganic matter, particularly K., must be had by the plant.

The Assimilating System of the Plant

All parts which contain chlorophyll, and which admit of exposure to the sun's rays, constitute the assimilating system of the plant.

The Raw Materials Required for Assimilation and Their Reception by the Assimilating Organs

1. Water.
2. Carbonic acid.

It has been shown how water and inorganic salts get into the plant.

How does carbonic acid enter the organism and how is it appropriated?

Absorption of Carbonic Acid by Land Plants

Obtained from air by leaves, through loosely jointed epidermis cells and stomata.

How this Takes Place

Leaves, exposed to sunlight, in an atmosphere containing a mixture of common air and carbonic acid, decompose the latter gas rapidly.

What are the Products of Assimilation Proper

As a result of the assimilation there is formed, within the cells containing chlorophyll, a carbohydrate of some kind:

Starch—

Is the first visible product of assimilation.

Glucose—

This replaces starch as another product of assimilation.

Lecture XI

APPROPRIATION OF NITROGEN BY PLANTS.

Amount of Nitrogen in the Plant

This consists—

a) of free nitrogen, which constitutes a part of the included air of the plant.

b) of combined nitrogen always present in the active cells as an essential component of living matter.

This forms 15 per cent of protoplasmic matter in plants.

N. is never absent from the living substance of plants.

For protoplasmic growth N. must—

1. Be present in available form.
2. Be adequate in amount.

Alkaloids

In large numbers of plants there is a certain

amount of matter called alkaloids, which contain, all of them, a certain amount of nitrogen.

Example—

Morphine in poppy.

Quinine in Peruvian bark.

Caffeine in coffee plant.

Sources of Nitrogen for the Plant

Free N of the air not directly available for plants.

Air traverses the plant and comes in contact with the tissues, but large share of atmosphere not utilized.

Nitrogen Compounds in the Atmosphere

Air contains minute amounts of NH_3 and HNO_3 and nitrous acid.

Nitrogen in Rain Water

N compounds of air are removed by rain and made available to plants in soil.

How N Compounds of the Atmosphere are Formed

1. Certain circumstances may cause the N in the air to unite with H and O to form nitric acid.

Example—Electric storms.

2. Nitric acid in rain, drops to the ground flows toward bodies of water.
3. Vegetable organisms of lower grade cause it to be changed to NH_3, gets into air and is thus absorbed by plants.

Available Nitrogen in the Soil

a) Animal matter of all kinds is rich in N, undergoes decomposition and gives rise to numerous compounds, one of which is NH_3.

In the presence—

1. Of free O.
2. Of an alkali.

Nitrates are formed which are available for assimilation by plants.

b) Vegetable matter in the soil.

This may undergo decomposition and set free NH_3, though in vegetable life decom position is more difficult than in animal life.

Nitrogen Used by Wild and by Cultivated Plants.

N from the above sources is available for plants.

In tropics, and in rich alluvial deposits near rivers, vegetation grows luxuriantly.

In ordinary soils it is profitable to augment the amount of nitrogen.

How This is Done:

1. Exposing soil to air by tillage.
2. Employment of natural or artificial manures.

Natural manures—

a) Excrement of animals.

b) Waste products from carcases of animals. (Animal matter comes directly or indirectly from vegetable kingdom. Hence this is restoration to plants of what some time was removed from them.)

In artificial fertilizers effort made to provide for plant mineral and nitrogen matters it requires:

These are calcium phosphate, K salts and nitrogenous matter.

Changes Which Takes Place in Albuminous Matters in Plants

Regarding the place in the plants where the formation of new proteid or albuminous matter occurs, two views are held:

1. That the change takes place in the chlorophyll cells.
2. That the change takes place in the petiole and stem.

Considerable quantity of nitric acid and nitrates are found in the roots and stem.

This disappears in leaves and all actively growing parts of the plant.

Conclusion is—

> That the changes resulting in the formation of organic albuminous bodies in the plant take place in leaves and other parts actively growing.

Appropriation of Sulphur

Amount of S.

It is an essential part of the albuminous matter of plants. Amount is 1 per cent.

How S. is Taken into the Plant

In form of Sulphates, chiefly calcium sulphate.

How S. is Utilized by the Plant

The oxalic acid produced by plants unites with $Ca.O_4$ to form calcium oxalate.

This is reduced by plants and united with albuminous matter to form organic compounds.

Lecture XII

CHANGES IN ORGANIC MATTER WITHIN THE PLANT.

The Principal Organic Products of Plants

These are:

1. Those which are free from nitrogen.
2. Those which contain nitrogen.

Products Free From Nitrogen

I. Carbohydrates

Are solid bodies, many of them soluble in water.

Two groups—

1. Cellulose group.
2. Sugars.
   Grape sugar.
   Fruit Sugar.
   Cane sugar.

Cellulose Group

1. Cellulose.

Is a product of the direct transformation of starch and is not again transformed to starch.

2. Starch.

Found in chlorophyll granules. Also found in reservoirs for food.

When transferred to points where it is to be consumed, it is transformed to sugar.

3. Inulin.

This is dissolved in the cell sap. It replaces starch in the roots and root-like stems of many perennials.

4. Dextrin.

Is produced as starch is being transformed to sugar. Found in spring sap of many trees. Found in bulbs as they grow.

5. The gums.

Substances produced by plants which dissolve in water or swell up in it, to form masses of soft, viscous liquid.

Example—Arabin, the chief constituent of gum arabic is obtained from a species of acacia.

Found in cherry tree gum. Slight amounts in many plants.

6. The pectin bodies.

Formed from pectose, which is an insoluble substance found in unripe fruits and fleshy roots.

Vegetable jelly is a familiar example of one of the products of such changes.

The Sugar Group

Members:

Grape sugar.

Fruit sugar.

Cane sugar.

Grape sugar.

Other names—glucose, dextrose. Is abundant in grapes and forms 10—30 per cent of the juice.

Figs—have 12 per cent.

Sweet cherries—9—10 per cent.

Apples and pears—7—10 per cent.

Fruit Sugar.

Is non-crystallizable. Is associated with dextrose in most ripe fruits.

Cane sugar.

Occurs in cell sap of many plants.

Indian corn—5—7 per cent.

Sugar beet—10—15 per cent.

Sugar cane—16—18 per cent.

II. Vegetable Acids

1. Oxalic acid.

Occurs in all plants in varied per cent.

Example—4 per cent in leaves of sugar beet.

There are many organic acids; oxalic acid is the most important. Many acids are poisonous.

Is widely distributed both in free state and in combination with soda or potash in the vegetable kingdom.

Is used by dyers and calico printers and as a hat bleach.

Many cases of poisoning attributed to it in Europe by eating plants containing it.

2. Tartaric acid.

Occurs in juice of grape, lemon, orange, and many others.

3. Citric acid.

6—9 per cent in juice of lemon and allied fruits, and associated with other acids in currants, cherries, etc.

4. Malic acid.

Occurs in juice of many fruits, and in the sap of many plants.

III. Fats or Glycerides

Fats occurring in plants are mixtures of stearin, palmatin or olein.

The oils of most seeds are free fatty acids.

Vegetable wax is closely allied to the fats.

IV. Certain Astringents

Examples:

a) Tannin.

b) Gallic acid.

The astringent principle in—

Cinchona.

Catechu.

Kino.

Occurs in buds, unripe fruits, petals of flowers (red), plants, poplar, birch.

V. Glucosides

Most glucosides are substances which under certain conditions, especially by action of organized ferments, are broken up into glucose and some other body capable of further decomposition.

Glucosides are soluble in water. Example—salicin, coniferin.

Glucosides are compounds of glucose with organic acids and are widely distributed in nature.

They mostly have a poisonous action on the heart—digitalin and other glucosides of the foxglove family.

VI. Ethereal Oils

Are volatile vegetable liquids. To them is due the fragrance of many flowers.

Examples—oils of orange, bergamot, rosemary, mints, oleander, attar of roses.

Associated with the ethereal oils are camphors.

Formed by the oxidation of ethereal oils.

Example—laurel camphors.

VII. Resins and Balsams

Balsam is a mixture of a resin with a volatile oil.

Resin is produced from volatile oil by oxidation.

Two examples of balsams:

1. Those containing cinnamic acid.

Example—balsams of Peru and Tulu.

2. Those which are purely oleo resinous. Balsam of copaiba, balsam of fir.

Lecture XIII

PLANT PRODUCTS, MOSTLY MEDICINAL, CONTAINING NITROGEN.

I. Albumen-like Substances

1. Albumen of plants.
2. Casein of plants.
3. Gelatin of plants.

Albumen of plants.

These are in watery solution and coagulate on application of heat or acids.

Casein of plants.

Is in solution and is precipitated by the action of rennet or dilute acids.

Gelatin of plants.

Tough, viscid masses found in plants, soluble in alcohol.

II. Asparagin

Is a crystalline body found in shoots of plants, which assists in the transfer of nitrogen.

III. The Alkaloids

These substances all possess the power of uniting with acids to form salts.

Example—morphine, quinine, strychnine.

Number of alkaloids—very great.

Found combined in plants in very many diverse forms.

Abundance.

More abundant in some parts of plants than in others.

Origin and function.

Very little is known of their origin and use to the organism.

Peculiar quality.

Many of them, applied to the very plant from which they are obtained, are poisonous.

Example—Morphine poisons poppy.

Meaning of word alkaloid.

A substance resembling an alkali. They do form salt-like substances with acids but here their likeness as to specific properties ends.

Composition of alkaloids.

All contain N. C. H. and O. (all except two of them).

Properties of alkaloids.

1. Usually non-volatile, solid, crystalline compounds.

2. They are variously soluble in ether, chloroform, alcohol and carbon bisulphide. They are usually insoluble in water.
3. The volatile alkaloids, nicotine for example, have vile odors.
4. The solid alkaloids, strychnine, morphine, are odorless, but have a bitter taste.

Physiological action of alkaloids.

Commonly alkaloids are active stimulants and intoxicants, producing results from atonic to strong tonic.

Extremes: muscular stimulation of strychnine and depressing action of morphine.

Heart stimulant—atropine.

" depressant—cocaine.

Occurrence of the alkaloids.

Are peculiarly a plant product. Believed to be protective agents to preserve plants, especially young plants:

a) From animals which would destroy them.

b) From animals which devour them.

Found in all parts of plants, but particularly in the seeds.

How found in plants.

They are found, in plants, united with plant acids.

Example—Meconic acid with morphine. Aconitic acid with aconitine.

Other acids form compounds with the alkaloids in the various plants in which they are found.

Examples—tannic, oxalic, malic, citric, quinic acids.

The combinations are broken up by action of strong bases, example—K. or Na. hydroxide. In this way separated from organic acids. The insoluble alkaloid is then filtered out.

Combination of alkaloids.

An alkaloid rarely exists alone in a plant, but is usually accompanied with others.

Examples—

Aconite—nine alkaloids.

Opium—seventeen alkaloids.

Peruvian bark—thirty-three alkaloids.

The five most important groups of alkaloids.

1. Liquid volatile alkaloids—nicotine, conine.
2. The opium group—morphine, codeine, laudanine, etc.
3. The tetanus producing group of alkaloids—strychnine, brucine, etc.
4. The aconite group—aconitine.
5. The mydriatic group—example—atropine.

Lecture XIV

BOTANY IN ITS RELATION TO MATERIA MEDICA.

Parts of important plants used to obtain crude drugs as materials for medicine.

The parts of plants which are utilized:

roots	stems	wood	bark
flowers	leaves	seed	fungus

Reason Why the Parts are Chosen

1. The crude drugs, in amount sufficient to warrant manufacture, are found in the parts used.
2. The drugs desired are either not present in other parts, or else only in minute quantities.

I. Some Important Drugs Obtained from Roots of Plants

1. Belladonna.

   Is from root of atropa belladonna.

What is made from the roots—

F. E. Belladonnae, tincture of belladonna. The alkaloid,—atropine.

2. Gentian.

Is from root of a plant of the same name.

What is made from the root—

F. E. gentian, tincture of G. Aromatic gastric stimulant. The powdered root is also administered.

II. Important Drugs Obtained from Underground Stems

1. Hydrastis.

Common name—golden seal or yellow root. The part used in preparation of drugs is the rhizome or underground stem.

What is made from the rhizome—

F. E. and tincture of hydrastis.

Chief uses in veterinary medicine—

In conjuctivitis; remedy for catarrh of upper air passages; gastric and intestinal stimulant.

2. Arnica.

Parts of plant used, rhizome, flowers, leaves. What is made from these parts—alcoholic solutions.

Commonest use—external use in case of bruises, wounds, etc.

3. Ginger (zinziber).

Part used, the rhizome.

What is made from the part—alcoholic solutions. Root ground to powder and used in that form.

Commonest use—as gastric stimulant.

4. Aconite.

Monkshood or wolfbane.

Part used—the tuber.

What is made from the part—alcoholic solutions.

Commonest uses—to lower temperature and pulse, and lessen pain; used in early stages of febrile diseases.

IV. Some Important Drugs Obtained from Wood

Quassia.

Part used—the splinters, chips and shavings of the plant.

What is made—alcoholic solutions.

Commonest use—as a bitter—as a digestive.

V. Some Important Drugs Made from the Bark of Plants

1. Quinine.

What made from—cinchona rubex, or Peruvian bark.

What is made—alcoholic solutions, alkaloids.

Commonest use—tonic and antipyretic in case of fevers.

2. Cascara sagrada or California buckthorn.

What made from—bark of buckthorn bush.

What is made from the bark—syrups, powders, alcoholic solutions.

Commonest use—a mild laxative for small animals.

3. Black haw

What made from—viburnum prunifolium bark.

What is made—alcoholic solutions of the drug, F. E. and the alkaloid viburnine.

Commonest use—to prevent abortion, particularly habitual abortion.

VI. Some Important Drugs Made from Flowers

1. Arnica.

What made from—the flowers of the arnica plant.

What is made—tincture of arnica.

Commonest use—externally for the relief of sprains, bruises, etc.

2. Cannabis indica.

What made from—the flowers of Indian hemp; Indian hashish.

What made—alcoholic solution, the tincture.

Commonest use—for relief of colic.

Some Important Drugs Made from the Leaves of Plants

1. Belladonna.

What made from—belladonna folia, or the leaves of the belladonna plant.

What is made—alcoholic solutions of belladonna and the alkaloid, atropine.

Commonest use—colics, rheumatism. Of alkaloid—eye stimulant.

2. Cocaine.

What made from—the leaves of the coca plant—erythroxylon coca folia.

What is made—the alkaloid cocaine.

Commonest use—as a local anæsthetic.

3. Digitalis.

What made from—the leaves of the foxglove plant.

What is made—the powder, the alcoholic solution, F. E. and several glucosides.

Commonest uses—as a diuretic, and as a heart stimulant.

Some Important Drugs Made From the Fruit and Seeds of Plants

1. Cardamoms.

   What made from—the fruit of the cardamom plant.

   What is made—alcoholic solutions of the drug.

   Commonest use—used with ground pepper, also with fruit of the capsicum plant, and ginger, as a gastric stimulant.

2. Nux vomica.

   What made from—seeds of strychnos nux vomica, a shrub of Hindustan.

   What is made—the alkaloid *strychnine. The powder—nux vomica.

   Commonest use of strychnine—as a powerful nerve stimulant. Of nux—to tone up stomach and intestines; general tonic.

3. Physostigma.

   What made from—seed of physostigma veninosum Balfour—calabar bean, a climbing plant found along Niger river, Africa.

   What is made—the tincture of physostigma. The alkaloid—eserine.

   Commonest uses—in obstinate constipation. The alkaloid used hypodermically.

Lecture XV

THE NOURISHMENT OF DOMESTICATED ANIMALS IN ITS RELATION TO THE VEGETABLE WORLD.

Plants do more than supply remedies for diseases of animals. They supply food with which to sustain life.

What is the Composition of the Animal Body

1. Water.

   Is the principal constituent as regards quantity—40 to 80 per cent of the given weight.

2. Ash.

   (Residue left after complete burning).

   Occurs chiefly in bones—2 to 5 per cent of the live weight.

3. Protein.

   Is the constituent which forms flesh, includes all nutrients which contain N. (albuminoids most important). The body, skin, flesh,

bones in part, vital organs, brain, nerves, that make up the bodily mechanism, are protein diluted with water, supported by ash of skeleton and rounded out with fat.

4. Fat.

Is 6 to 30 per cent of the live weight.

Is C. H. and O. but no N. These from animal, vegetable and mineral matter, and converted to flesh, fat, bone, milk and energy.

Composition of Food Materials

Close similarity between the constituents of animals and plants.

The four groups of substances which enter into the composition of animals are found in their food plus carbohydrates.

They are cellulose, woody tissue, starch, sugar, gums, etc.

The Composition of all Substances Alike, Whether Found in Plants or Animals

Water.

In dry foods—9 to 15 lbs. per 100.

In green food and silage—75 to 90 per 100.

Water adds to the palatability of food, but does no more good than drinking water.

2. Ash.

Lime, magnesia, soda, potash and other compounds used largely in making bone.

Ordinary vegetable food stuffs contain an abundant supply of these materials for use of animal.

3. Fats.

These are found in plants in impure form mixed with wax, resins, coloring matter. They are turned into animal fat.

4. Carbohydrates.

These are of two groups—

1. Starch, sugar, gums and similar substances.
2. Cellulose or fibre. (Composes walls of cells). Coarse fodders like hay, and straw, contain much fibre.

5. Proteins.

Compounds containing N.

(All other constituents of food stuffs contain no N.)

Protein enters largely into the composition of blood, skin, muscles.

Lecture XVI

PLANT CLASSIFICATION IN ITS RELATION TO VETERINARY MEDICAL STUDIES.

Two Great Series of Plants

1. Cryptogams or flowerless plants.
2. Phænogams or flowering plants.

Beginning with Lowest and Going to Highest, the Classes of Cryptogams are

1. Bacteria
2. Algæ
3. Fungi
   - Mildews
   - Rusts
   - Smuts
   - Moulds
   - Toad-stools
4. Liverworts
5. Mosses
6. Ferns

The Interest of Veterinarians in the Bacteria and the Fungi

Bacteria cause infectious diseases.

Fungi cause diseases directly or indirectly by poisoning foods.

Phaenogams

Separable into two classes—

1. Gymnosperms.

   Ovules not enclosed in an ovary.

2. Angiosperms.

   Ovules enclosed in ovary.

Sub-classes of angiosperms—

Monocotyledonous.

Leaves produced in embryo alternate.

Dicotyledonous.

Leaves formed in embryo opposite.

The Interest of this Great Series, the Phaenogams, to Veterinarians is that from Them are Obtained

a) A multitude of crude drugs which are organic compounds formed by these plants.

b) The numerous forage plants belonging to this series—

grasses	bulbs
cereals	tubers
graminaceæ	roots

c) The numerous flowering plants destructive to live stock.

Lecture XVII

SPECIAL ILLUSTRATIVE LECTURE ON COTTON FROM THE ECONOMIC POINT OF VIEW.

1. Cotton as a plant requiring heat.
2. Cotton fibre as fabric.
   a) Summer cotton cloths.
   b) Winter cotton cloths mixed with wool, or lining wool garments.
   c) Mercerized cotton.
3. Cotton as a food.
   a) of animals.
      Hulls—fattening value.
      Flour—coloration.
      Poisoning of hogs from cotton seed meal.
   b) Of man.
      1. Cotton-seed oil refining—enormous size of crushing industry.
      2. Cotton-seed oil as olive oil. Its value as digestive and medicinally.

3. Cotton-seed oil in "lard compounds."
4. Cotton-seed oil in oleomargarine manufacture.

Lecture XVIII

SUMMARY REMARKS ON THE VALUE OF BOTANICAL STUDIES TO VETERINARY STUDENTS.

Concluding Remarks

1. The many branches of botany.
2. The chief advantages of a study of botany to the veterinary student—
   a) As an introduction to the study of materia medica,
   b) To enable him to better appreciate the study of feeds and feeding.
   c) In order to better present information later, on poisonous plants destructive to live stock.
3. How this three-fold purpose has been kept in mind in this course of lectures.

REVIEW QUESTIONS IN BOTANY PREPARATORY TO VETERINARY MEDICAL STUDIES

1. What is a plant cell?
2. Of what does a plant cell consist?
3. What is the essential element of a plant cell?
4. Describe the appearance of protoplasm.
5. What is the nucleus and what is the nucleolus, and what is their appearance and relation to the other parts of the plant cell?
6. The cell wall—how is it formed? What is its appearance? Of what is it usually composed?
7. To what four modifications is the plant cell wall subject? Describe each separately and give illustrations of each form of modification.
8. What is plant wax and how is it formed?
9. How are plant mucilages and gelatin formed?
10. Does the making of "flax seed tea" illustrate a form of cell modification? If so, what form?
11. Is the cell wall formed from protoplasm? If so, how does this come about?
12. What are plastids?
13. Name the three types of plastids?
14. How is chlorophyll formed and to what is its greenness due?
15. Where are chlorophyll granules formed? Describe their appearance, shape, size.

16. What is the effect upon chlorophyll, caused by placing in the dark plants containing it?
17. What are proteid granules? What is their appearance?
18. What is starch? What is its appearance? Where is it found in plants?
19. Name some of the substances found dissolved in the cell sap of plants.
20. What are plant crystals and where are they found?
21. Describe the character of protoplasm of plants.
22. What are the characteristics of the nuclei of plants? Compare the nucleus with the other parts of the cell.
23. What can you say of the activity of the protoplasm in the cells of plants?
24. What is meant by the circulation of protoplasm?
25. What conditions affect the rate of motion of protoplasm?
26. Speak of the relation of protoplasm to heat, light, electricity, mechanical irritation, gravitation, moisture.
27. What can you say of the structure of protoplasm?
28. What is the relation of protoplasm to the cell wall and to the protoplasm of the adjoining cells?
29. What is the mode of growth of the cell wall?
30. Speak of the fibrillar character of protoplasm. Has protoplasm of one cell any relationship to that of nearby cells?
31. In what does the growth of plants consist?
32. What chemical or physical phenomena accompany the production of new cells of plants or the increase in size of old ones?
33. Show in what sense available matter for growth can be had from the air or the soil?

34. What is meant by respiration of plants?

35. What is meant by transmutation of materials in plants?

36. What is meant by assimilation as it is carried on by plants?

37. How have the phenomena which occur in the growth of plants been studied?

38. In growth do changes take place chiefly in the nucleus? In what way?

39. Describe cell division (karyokinesis).

40. How does the cell wall form for completion of the cell during the late stages of the formation of cells?

41. Describe the effects of temperature, light and oxygen on the growth of cells.

42. In speaking of the properties of cells in the act of growth point out the meaning of tension, geotropism, heliotropism, hydrotropism and thermotropism.

43. In the growth of the bean and squash what expansion power is shown?

44. What is meant by liquids which are non-diffusible? Illustrate your answer.

45. Describe the two forms of diffusion of liquids.

46. What is meant by osmosis?

47. Is the plant cell an osmotic apparatus? In what way?

48. What is meant by crystalloids? Are they readily diffusible in plants?

49. What is meant by colloids? Are they readily diffusible in plants?

50. In what ways do temperature, the strength of salts and the kinds of salts affect diffusion?

51. Describe how the roots of plants are constructed by nature for the purpose of absorption.

52. What is meant by the "root system"? Is the area occupied by the roots of plants large?

53. What influences affect the development of roots?

54. In forest and shade trees do the roots of the trees extend to a great length from the base of the tree?

55. What is meant by the residue of plants; how is it formed; what is its appearance?

56. How can the amount of water in a plant be determined?

57. What is meant by the ash of plants? About what percentage of ash is there in plants?

58. From what are the combustible parts of plants derived?

59. From what are the incombustible parts of plants derived?

60. Name some of the materials that plants derive from the soil?

61. How are soils formed?

62. In what ways do soils become mixed with organic matters?

63. How do moisture and carbon dioxide change the character of the soils?

64. Show how water is a distributor of materials in soils and changes the character of soils.

65. Mention some of the kinds of soils and describe their character.

66. Show how the growth and nutrition of plants is affected by liquids, gases and heat.

67. Have soils the power to remove saline and organic matter passing through them in solution? How does this affect the nutrition of plants?

68. What is meant by the ash constituents of plants?

69. Where are the ash constituents found in plants?

70. Mention some of the constituents of the ash of plants.

71. How may the principal organic products formed by plants be grouped?

72. What are carbohydrates?

73. Name some of the substances which may be placed in the cellulose group of carbohydrates.

74. What three forms of sugars should be placed in the sugar group of carbohydrates.

75. Give some of the other names given to grape sugar. In what fruits is this sugar found?

76. What is fruit sugar? How does it differ from grape sugar? In what fruits is it found?

77. Is cane sugar found in any other plant besides the sugar cane—for example, sugar beet and Indian corn? If so, in what amounts?

78. What is meant by a plant solid?

79. Speak of the occurrence of oxalic acid in plants; its distribution in plants; its use in manufacturing.

80. Are tartaric and citric acids formed by plants? Name some compounds of these acids with other substances which are used in veterinary practice.

81. What is a glyceride?

82. Of what fats, formed by plants, are glycerides composed?

83. What is vegetable wax? What are cerates? Are they used in veterinary practice?

84. Name some astringents formed by plants.

85. Name some plants that form tannic acid and tannates.

86. What is tannic acid used for in veterinary practice?

87. In what parts of plants are astringents usually found?

88. What is a glucoside?

89. Are glucosides soluble in water? Name several glucosides.

90. What organ of the body, in domesticated animals, is mostly affected by the action of glucosides? Illustrate this by mentioning the effects of glucosides obtained from the foxglove plant.

91. What is an ethereal oil?

92. To what is the fragrance of an ethereal oil due?

93. Name several ethereal oils?

94. What are camphors and in what way are they related to ethereal oils?

95. Mention several kinds of camphors.

96. What is the appearance of the camphors and what effect do they have on the heart? In what are they soluble?

97. What is a resin?

98. What is a balsam?

99. Give several examples of balsams.

100. What are the uses of balsams in veterinary practice?

101. Name several albumen-like substances produced by plants?

102. Is there such a thing as plant albumen? Is it ever held in aqueous solution?

103. What is asparagin and where is it found in plants?

104. How would you define the term alkaloids? Name several common alkaloids. Are alkaloids ever formed by anything else besides plants?

105. What can you say of the number of alkoloids in nature? Of the forms in which alkaloids appear?

106. How do alkaloids originate and of what use are they to plants which form them?

107. What are the elements always found in an alkaloid?

108. Are alkaloids soluble in water? In what are they soluble?

109. Are alkaloids usually volatile? Give an illustration of a volatile alkaloid.

110. What can you say of the physiological action of alkaloids?

111. What parts of plants contain alkaloids?

112. How are alkaloids separated from their union with other substances in plants?

113. Do alkaloids exist alone in a plant or are they found combined with other alkaloids in the same plant?

114. How do opium and Peruvian bark illustrate the facts asked for in Question 113.

115. Mention some of the alkaloids found in the opium group of alkaloids.

116. Name a mydriatic alkaloid.

117. From what parts of plants are crude drugs abtained?

118. Are crude drugs found equally distributed throughout medicinal plants in which they occur?

119. Mention how belladonna and gentian illustrate drugs taken from the roots of plants. What drugs are obtained from these plants and what are their principle uses?

120. Do the stems of plants sometimes produce drugs? How do hydrastis, arnica and ginger illustrate this point?

121. Mention a drug obtained from the wood of plants. Of what use is this drug in pharmaceutical work?

122. Mention some drugs commonly found in veterinary practice which are obtained from the bark of plants and state the uses of the drugs.

123. Are arnica and cannabis indica obtained from the flowers of plants? What drugs are obtained from these plants and what are their uses?

124. What important alkaloid is obtained from the leaves of the erythroxylon coca plant? What drugs are obtained from the leaves of the foxglove plant?

125. Mention some drugs obtained from the seeds of plants, speaking of their use in veterinary work.

126. Do plants supply food for animals as well as remedies for their ills?

127. What percent of the animal body is composed of water?

128. When an animal body is completely burned, from what part of that body does the ash come?

129. What parts of the animal body are largely composed of protein?

130. What percentage of the animal body consists of fat?

131. Does the composition of food materials obtainable for animals from plants bear any relation to the needs of the animal?

132. How much of the substance of food plants is composed of water?

133. What parts of the composition of plants are largely utilized in forming the bones of animals?

134. What are cryptogamous plants?

135. Name the different classes of cryptogams.

136. Of what special interest are the bacteria and fungi to veterinarians?

137. Of what special interest to veterinarians are the fungi? Name some of the diseases of animals caused by fungi.

138. Of what special interest to veterinarians are ferns? Do ferns cause diseases of domesticated animals?

139. What are phaenogamous plants? Name several phaenogamous plants.

140. From what class of plants are materials of medicine and foods of animals for the most part obtained?

141. Name some diseases of animals caused by phaenogamous plants.

142. Define the meaning of the term botany. Name some of the branches of botany.

143. What branches of botany should be of interest to veterinarians?

144. What reasons are there why the veterinarian should have an interest in the plant world as well as the animal and mineral worlds?

145. From which of the three, mentioned in question 144, are the materials of medicine mostly derived?

146. Why will a knowledge of botany help the veterinarian to understand the natural law governing the proper nutrition of animals and the proper feeds to be given to animals?

147. Why would a veterinarian who has studied botany better appreciate diseases of animals?

148. Are there many diseases of animals caused by the propagation of forms of plant life within animal tissue? Name some of these diseases. Are the diseases thus formed as destructive as those diseases of domesticated animals caused by low forms of animal life (protozoa, amoeba, coccidia)?

149. Are there many plants which cause poisoning of animals which eat them? If so, name two plants which thus cause the death of animals?

150. In your opinion what plants cause most of the destruction of animals? Give five reasons why the veterinary student should study botany.